THE DESCRIPTION OF *HYPOGLOSSUM SUBSIMPLEX* SP. NOV. (DELESSERIACEAE, RHODOPHYTA) FROM THE FLORIDA KEYS, GULF OF MEXICO

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ABSTRACT - *Hypoglossum subsimplex* sp. nov. is described from the Florida Keys, Gulf of Mexico, which raises the total to 8 species of *Hypoglossum* occurring in the western tropical and subtropical Atlantic. Distinctive characteristics of the new species include its very small size (to 6 mm in height), its usually simple or sub-simple blades, its long, continuous tetrasporangial sori, the restriction of the tetrasporangia to the primary layer, and the absence of a corticated midrib.

RÉSUMÉ - *Hypoglossum subsimplex* sp. nov. est décrit de Florida Keys, Golfe du Mexique, ce qui porte à huit le nombre total d'espèces d'*Hypoglossum* rencontrées dans l'Atlantique tropical occidental et subtropical. Les caractères distinctifs de cette nouvelle espèce comprennent une taille très réduite (jusqu'à 6 mm de hauteur), des lames généralement simples ou sub-simples, des sores tétrasporangiaux longs et continus, des tétrasporocystes limités à la couche primaire, et l'absence de corticarion de la nervure (traduit par la Rédaction).

KEY WORDS : Delesseriaceae, Florida, Gulf of Mexico, *Hypoglossum*, *H. substmplex*, marine algae, Rhodophyta.

INTRODUCTION

Four species of the genus *Hypoglossum* (Delesseriaceae, Rhodophyta) were listed in Wynne's (1986) checklist of benthic marine algae for the tropical and subtropical Western Atlantic. These included the Type of the genus, *H. hypoglossoides* (Stackhouse) Collins & Hervey, a pair of species originally described from Key West, Florida, by Harvey (1853), namely, *H. involvens* (Harvey) J. Agardh and *H. tenuifolium* (Harvey) J. Agardh, and the then-recently described *H. anomalum* Wynne & Ballantine (1986). In the subsequent years, two new species were described: *H. rhizophorum* by Ballantine & Wynne (1988) and *H. simulans* by Wynne, I. Price, & Ballantine (1989). In addition, *H. caloglossoides*, which had been described from Lord Howe Island in the South Pacific (Wynne & Kraft, 1985), was reported to occur in the Florida Keys (Bucher *et al.*, 1990). Even with this growing richness in the diversity of species now recognized in this flora, an additional species appears to warrant recognition and description, which is the purpose of this paper.

MATERIALS AND METHODS

The host material, *Halimeda tuna* (Ellis et Solander) Lamouroux, was promptly preserved in 5% formalin-seawater solution. The small thalli of the *Hypoglossum* were picked off the host with a forceps and under a dissecting microscope. They were then placed on glass slides and stained with 1% aniline blue acidified with dilute acetic acid. The mounts were then rinsed of excess stain, ringed with liquid glucose (Karo® corn syrup) and placed in a warming oven to allow them to solidify; some of the mounts were left unstained. A standard Zeiss research microscope equipped with a camera lucida and a camera-back was used to prepare the figures. Herbarium abbreviations follow Holmgren *et al.* (1990).

OBSERVATIONS

Vegetative Structure

One to several (up to 6) erect blades arise from a small attachment disc (Fig. 1-3, 10). Fully grown blades reach only 6.0 mm in height and 1.0 mm in width. These primary blades usually bear some lateral bladelets (Fig. 1), which always arise from the midline. Injured blades can produce bladelets from the cut surface. Blade margins are entire. Occasionally 1- to 3-celled rhizoids can be produced from marginal cells of the blade. The apical organization involves all tertiary initials reaching the blade margin (the "*Hypoglossum* type") and all cells of second-order rows bearing third-order rows (the "*H. hypoglossoides* type") (Fig. 4). Intercalary cell divisions are absent. The vegetative blade is entirely monostromatic except for the midline, which is three-cells in thickness (the primary axial cell and the pair of transverse pericentral cells). There is no rhizoidal cortication covering the midline (Fig. 10). Cells of the alae in mature blades are elongate, measuring 40-66 µm long and 8-18 µm wide, but are not arranged in longitudinal rows in reference to the long axis of the blade.

Reproductive structure

The male plants bear spermatangial sori on both blade surfaces and on both sides of the midline (Fig. 2 and 5). The sori are generally in diagonally arranged (chevron-like) and in a somewhat random pattern, with both small isolated sori and larger confluent areas.

The female plants produce carpogonial branches along the midline, the cystocarps thus being restricted to the midline (Fig. 6). Usually only one but sometimes two cystocarps can be developed on a single blade (Fig. 3). Cystocarps measure 140-150 µm in diameter. The pericarp of the cystocarp is simple, that is, unadorned, and has a small ostiole.

Tetrasporangial plants produce the sori arranged on either side of the midline (Fig. 1). The tetrasporangial sorus is long and continuous (Fig. 9). The maximum soral length measured, including the part from which spores had already been shed, was 2580 µm. The sorus extends close to the distal end of a fertile blade (Fig. 7). The

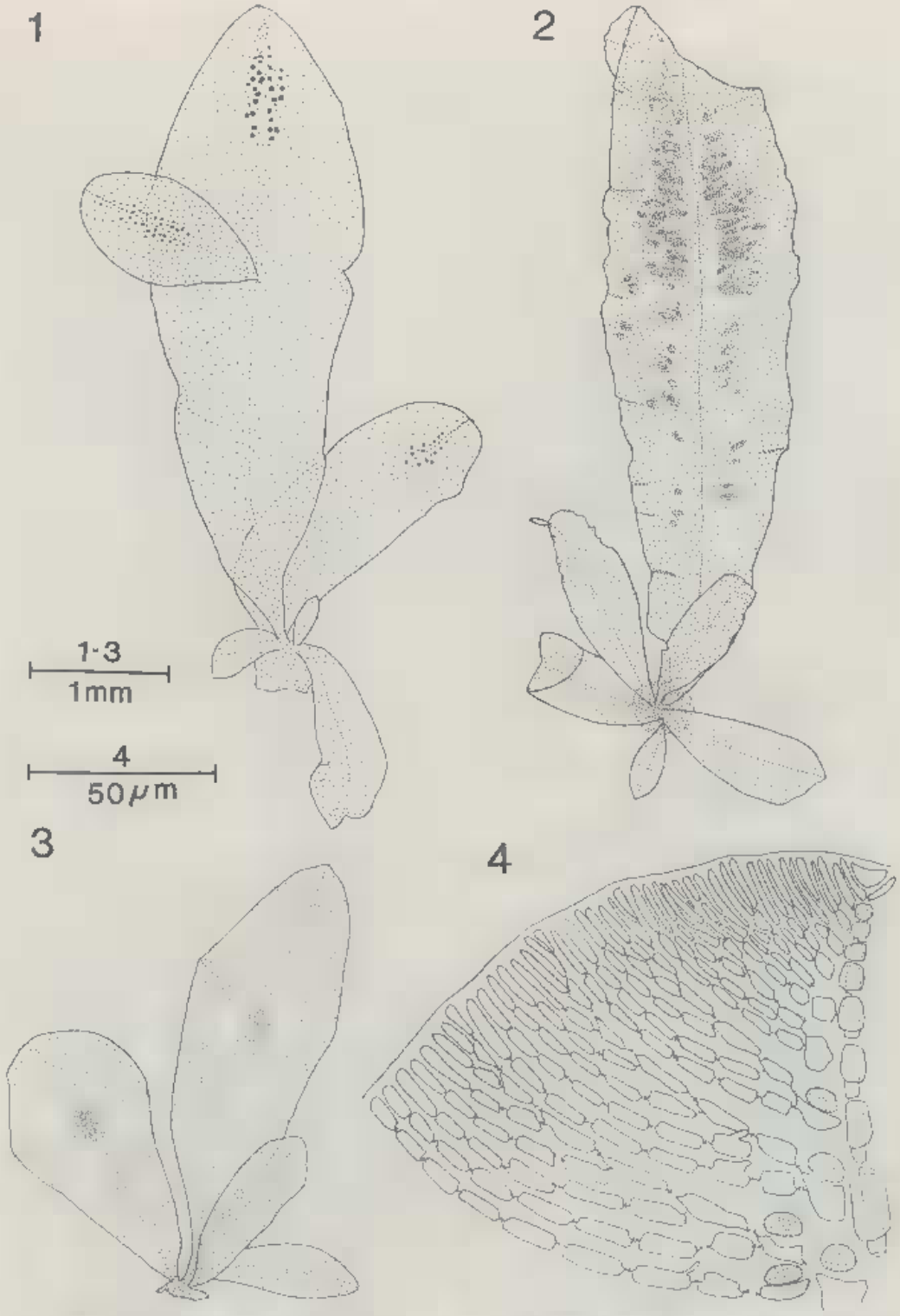
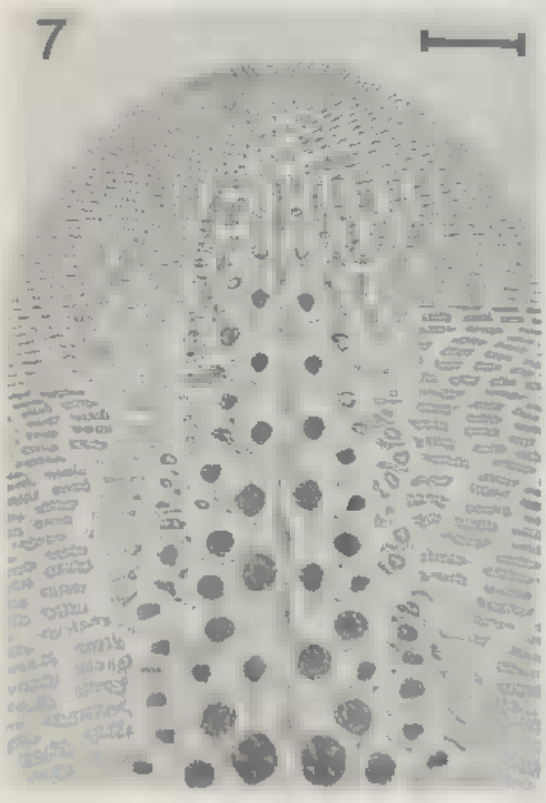
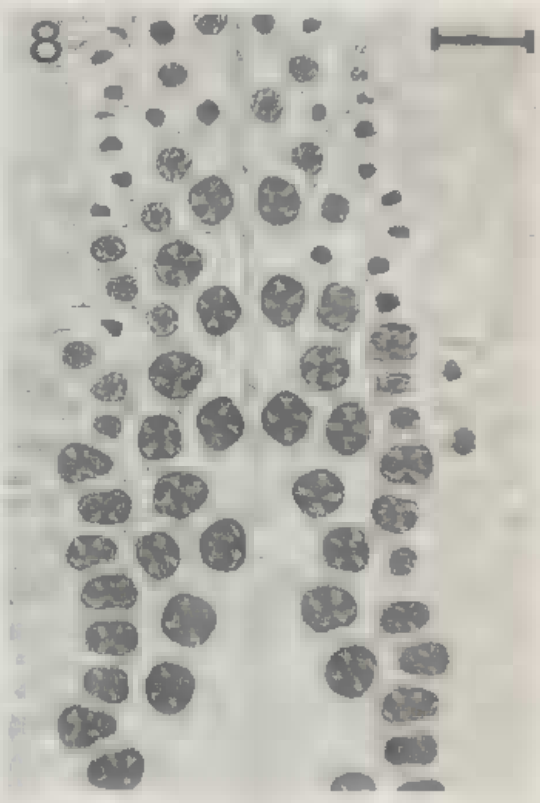


Fig. 1-4. *Hypoglossum subsimplex*. Fig. 1. Tetrasporangial thallus. Fig. 2. Spermatangial thallus. Fig. 3. Female thallus, with young cystocarps located on the midline of the blades. Fig. 4. Apical organization, showing one half of a blade, and with tetrasporangial primordia (shaded) being cut off within ■ segments of the apical cell.





lateral pericentral cells but not the transverse pericentral cells participate in the formation of the sporangia (Fig. 7). Typically, the two second-order cells adjacent to the lateral pericentral cells as well as nearby third-order cells are involved in the formation of sporangia (Fig. 8). Young tetrasporangia can be observed to have already been cut off from the lateral pericentral cells on the 8th segment proximal to the apical cell of a blade (Fig. 4). Primary cells cut off tetrasporangial primordia in an acropetal sequence. It appears that cover cells are then cut off, one to each blade surface, by the primary cell following the formation of the tetrasporangial primordium. These cover cells undergo no further division, and cortical cells are not present, such that the tetrasporangia lie in a single so-called primary layer within the fertile blade. The sporangia are somewhat cruciately rather than tetrahedrally divided, and at maturity the tetrasporangia measure 40-48 μm in diameter.

Hypoglossum subsimplex Wynne sp. nov.

Fasciculus laminarum simplicium aut subsimplicium erectarum delicatarum e base disciformi orientium; ramificatio tantum ad unum ordinem; laminae tantum usque 6 mm altae; margines laminae laeves; costa corticata destituta; omnes cellulae serierum cellularum secundi ordinis series cellularum tertii ordinis procreant; tetrasporangia tantum in una lamina procreant, cellulis ambo serierum secundi ordinis et tertii ordinis abscissa, vicina costa laminae, sic laterales cellulas pericentrales includentibus; sorus tetrasporangiorum non discretus in longitudino sed ad aliquot distanciam currens; sori spermatangiorum plerumque in turmis diagonaliter aut irregulariter dispositi, parvi et sejuncti aut confluentes; uno aut duo cystocarpiae in quoque femina lamina, in costa locatae.

Diagnosis: A cluster of simple or subsimple erect, delicate blades arising from a discoid base; branching to one order only; blades only up to 6 mm tall; margins of blade smooth; corticated midrib lacking; all second-order row cells producing third-order rows; tetrasporangia produced in only the primary layer, cut off by cells of both second- and third-order rows in vicinity of midline of blade, thus including lateral pericentral cells; tetrasporangial sorus not discrete in length but running continuously for some distance; spermatangial sori arranged usually in diagonal or irregular groups, small and isolated or becoming confluent; 1 or 2 cystocarps per female blade, located on the midline.

Holotype: Wynne 9959 (slide in MICH), on *Halimeda tuna*, collected by M. D. Hanisak, 19 June 1994, Content Keys, lee side of Florida Keys, Florida, U.S.A.
Isotypes: slides deposited in MEL, PC, UC, US.

Fig. 5-8. *Hypoglossum subsimplex*. Fig. 5. Spermatangial blade. Fig. 6. Cystocarpic blade. Fig. 7 and 8. Distal (Fig. 7) and proximal (Fig. 8) views of a single tetrasporangial sorus on the Holotype. Scale bars: 100 μm in Fig. 5 and 6; 40 μm in Fig. 7 and 8.

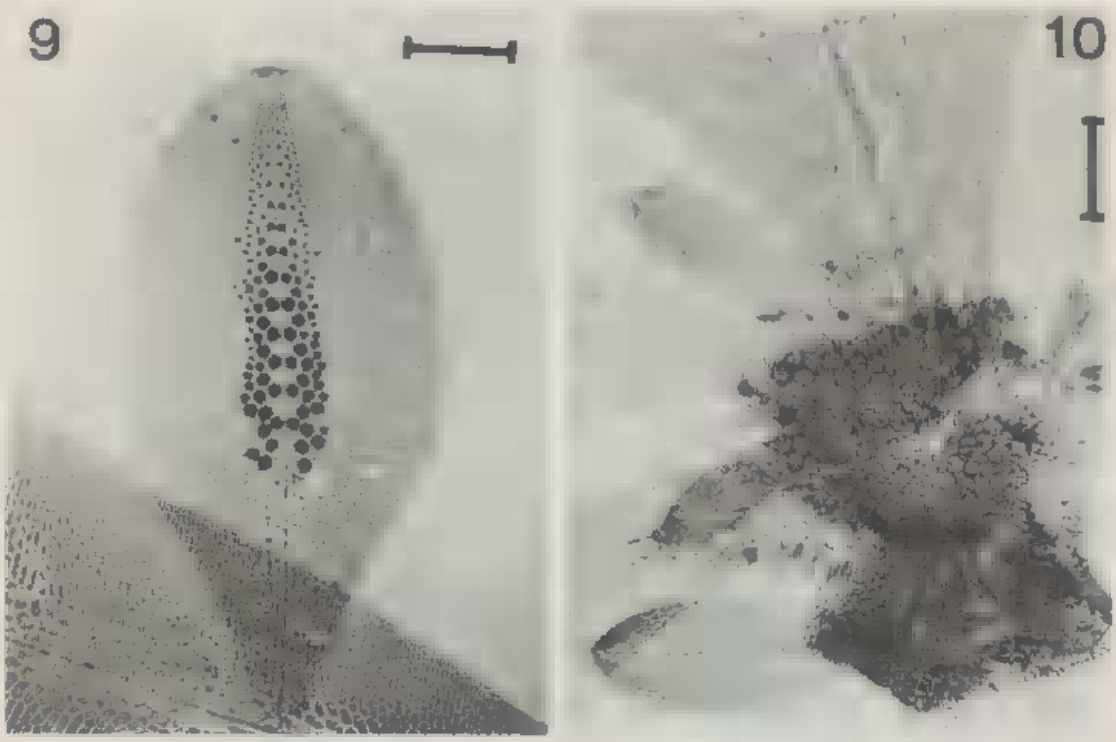


Fig. 9 and 10. - *Hypoglossum subsimplex*. Fig. 9. Portion of tetrasporangial thallus, with sorus on lateral branch. Fig. 10. Base of thallus, showing some utricles removed when detached from host *Halimeda*. Scale bars : 200 µm in Fig. 9; 100 µm in Fig. 10.

In addition to the *Hypoglossum subsimplex*, the host plant, *Halimeda tuna,* was also epiphytized by other algae, including *Griffithsia heteromorpha* Kütz., *Dictyota* sp., *Crouania attenuata* (C.Ag.) J.Ag., the *Falkenbergia hillebrandii*-stage of *Asparagopsis taxiformis* (Delile) Trev., *Polysiphonia sphaerocarpa* Børgesen, *Heterosiphonia crispella* (C. Ag.) Wynne, *Lomentaria* sp., and colonial diatoms.

DISCUSSION

Hypoglossum Kützing, with about 23 recognized species, occurs in tropical, subtropical, and temperate seas of both hemispheres. Taxonomic criteria include habit and organization (entirely erect or partially prostrate; monopodial or ramisympodial), apical organization, patterns of tetrasporangial and spermatangial sori, and whether the tetrasporangia are formed in a single (primary) layer or in several layers, i.e., involving the cortical cells.

In a limited number of species of *Hypoglossum* tetrasporangia are produced only by the primary layer of cells, that is, not by cortical cells (Wynne, 1989). This group of species includes *H. protendens* (J. Ag.) J. Ag., *H. dendroides* (Harv.) J. Ag.,

H. minimum Yamada, *H. geminatum* Okamura, and *H. sagamianum* Yamada as well as *H. subsimplex*. In both *H. protendens* and *H. dendroides* only the inner second-order cells bear third-order cell rows, and the transverse pericentral cells are commonly involved in tetrasporangium formation (Womersley & Shepley, 1982), features which effectively separate them from *H. subsimplex*.

Hypoglossum minimum, known from southern Japan, obviously is closely related to the new species. In addition to the restriction of the tetrasporangia to the primary layer, *H. minimum* shares with *H. subsimplex* several other features, such as the small stature of the blades and their origin from a discoid holdfast. The height of *H. minimum* has been reported as 1-4 mm (Yamada, 1936), 2-5 mm (Konno & Noda, 1980), and up to 9 mm (Yoshida & Mikami, 1986). Other shared features are the participation of lateral pericentral cells in the production of tetrasporangia and the apical organization in which tertiary rows are produced by all second-order cells. Several critical differences, however, can be cited to distinguish these two species. The tetrasporangial sorus in *H. minimum* is "well defined" (Yoshida & Mikami, 1986), "discrete" (Wynne *et al.*, 1989) and "forming a round-shaped group" (Konno & Noda, 1980) unlike the elongate, more or less continuous and indeterminate sorus characteristic of *H. subsimplex*. Another difference is that the production of one order of lateral blades is commonly expressed in *H. subsimplex*, in contrast to the situation in *H. minimum*, in which blades are always simple (Konno & Noda, 1980), "simple or rarely ramified" (Yamada, 1936), or "very rarely" branched (Yoshida & Mikami, 1986). The midline of *H. subsimplex* is uncorticated, but that of *H. minimum* is slightly corticated (see fig. 3 in Yoshida & Mikami, 1986). Finally, each sporangium is associated with two "cover cells" (see Womersley & Shepley, 1982), one to each surface, in *H. subsimplex*, whereas a layer of small cortical cells cover the tetrasporangial sorus in *H. minimum* (see fig. 14 in Yoshida & Mikami, 1986).

Hypoglossum geminatum differs from the new species by having a prostrate primary axis, forming branches always in opposite pairs, and producing tetrasporangia only from second-order cells (Yoshida & Mikami, 1986). Thalli of *Hypoglossum sagamianum* are small, 2-4 cm (Yamada, 1941), with branching to about 3 orders. This species is distinctive with its tetrasporangial sori being restricted to relatively small ultimate blades and in the absence of third-order cells within the sorus (Mikami, 1987).

Some reduced forms of *Hypoglossum* have been described from the Adriatic and Mediterranean Seas, such as *H. minutum* Kützing (Kützing, 1843, 1849, 1866) and *H. crispum* (Zanardini) Kützing (Kützing, 1845, 1866), but these taxa have usually been relegated to taxonomic synonymy within *H. hypoglossoides* (Hauck, 1885; DeToni, 1900). The tetrasporangial sori in *H. hypoglossoides* are in continuous bands on both sides of the thickened, conspicuous midrib (Schneider & Searles, 1991; Maggs & Hommersand, 1993). The typical form of *H. hypoglossoides* is branched to several orders, easily separating it from *H. subsimplex*.

Another somewhat small-statured species is *Hypoglossum parvulum* described by Levring (1941) from the Juan Fernandez Islands, Chile. Thalli of that species reach about 4 cm in height, and blades are 3 mm wide, and they are richly branched from the midrib. Unlike the pattern in *H. subsimplex*, the tetrasporangial sori in *H. parvulum* are located in the lower portion of the blades.

Table I: Comparison of Western Atlantic species of *Hypoglossum*

	habit	branching	apical organization[1]	midrib	tetrasporangia from lateral pericentral cells	distinctive features
H. anomalum	mostly prostrate	usually opposite	Type 1	broad, well developed	yes (as well as from transverse peric. cells)	blades emerge between midrib and margin of parent blade
H. caloglossoides	mostly prostrate	opposite	Type 1	uncorticated	yes (as well as from transverse peric. cells)	regular constriction of creeping axes with pattern of nodes and internodes
H. hypoglossoides	erect	alternate & opposite	Type 1	usually well developed	no	broad sterile region separating tetrasporangial sori
H. involvens	erect	alternate	Type 1	uncorticated	yes (lying in a narrow sorus)	marginal bullations; incurved apices
H. rhizophorum	mostly prostrate	alternate or unequal pairs	Type 1	uncorticated	yes (as well as from transverse peric. cells)	creeping axes giving rise to simple blades
H. simulans	mostly prostrate	alternate	Type 2	usually uncorticated	yes (but not by transverse peric. cells)	bladelets arise on basal segment of parent blade
H. subsimplex	erect	simple or subsimple	Type 1	uncorticated	yes (but not by transverse peric. cells)	tetrasporangia restricted to primary layer
H. tenuifolium	erect	alternate	Type 2	uncorticated	yes	greenish color; blade often overlapping, imbricate

[1] Type 1: all cells of 2nd order rows bear 3rd- order rows; Type 2: only some cells of 2nd-order rows bear 3rd-order rows.

There are two basic types of apical organization in *Hypoglossum*: 1) all cells of the second-order rows bear third-order rows; or, 2) not all cells of the second-order rows bear third-order rows (Womersley & Shepley, 1982). The apex of *H. subsimplex* is of the former pattern, which is characteristic of the majority of species in the genus (Wynne *et al.*, 1989).

Several species of *Hypoglossum* have serrate blade margins; this group of species includes *H. serratifolium* Okamura (Mikami, 1985), *H. guineense* Lawson & John (1982), *H. armatum* (J. Ag.) J. Ag., *H. revolutum* (Harv.) J. Ag., and the fimbriate form of *H. harveyanum* (Womersley & Shepley, 1982). The new species is clearly easily separable from these species.

Table I presents the eight species of *Hypoglossum* currently recognized as occurring in the tropical and subtropical Western Atlantic and a number of taxonomic features which serve to characterize them.

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